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3600
PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

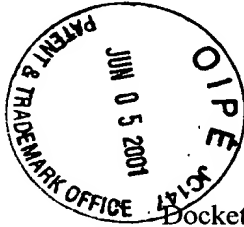
In re the Application of

Val J. DARE-BRYAN

Application No.: 09/820,707

Filed: March 30, 2001

For: VEHICLE SUSPENSION SYSTEM



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JUN 11 2001

TO 3600 MAIL ROOM

Docket No.: 105760

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Technology Center 2600
ASW
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CLAIM FOR PRIORITY

Director of the U.S. Patent and Trademark Office
Washington, D.C. 20231

Sir:

The benefit of the filing date of the following prior foreign application filed in the following foreign country is hereby requested for the above-identified patent application and the priority provided in 35 U.S.C. §119 is hereby claimed:

United Kingdom Provisional Patent Application No. 0007694.3 filed March 31, 2000

In support of this claim, a certified copy of said original foreign application:

 X is filed herewith.

 was filed on in Parent Application No. filed .

 will be filed at a later date.

It is requested that the file of this application be marked to indicate that the requirements of 35 U.S.C. §119 have been fulfilled and that the Patent and Trademark Office kindly acknowledge receipt of this document.

Respectfully submitted,

Darle M. Short
Registration No. 29,213

Scott M. Schulte
Registration No. 44,325

DMS:SMS/sxb

Date: June 5, 2001

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The Patent Office
Concept House
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South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

Dated 9 April 2001

OLIFF & BERRIDGE, PLC

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APPLICANT: Val J. DARE-BRYAN

APPLICATION NO.: U.S. Application No. 09/820,707

FILED: March 30, 2001

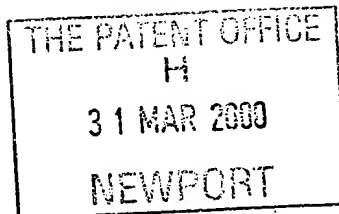
FOR: VEHICLE SUSPENSION SYSTEM

ATTORNEY DOCKET NO.: 105760

Patents Form 1/77

Patent Act 1977

(Rule 16)

The
Patent
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JUN 11 2001

The Patent Office

Cardiff Road
Newport
Gwent NP9 1RH**Request for grant of a patent**

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

1.	Your reference	DC/P5557UK	SIMAR00 E525753-2 D00351 P01/7700 0.00-0007694.3	
2.	Patent application number (The Patent Office will fill in this part)	31 MAR 2000	0007694.3	
3.	Full name, address and postcode of the or of each applicant (underline all surnames)	Transportation Techniques LLC 1705 East 39 th Avenue Denver, Colorado, USA.		
	Patents ADP number (if you know it)			
	If the applicant is a corporate body, give the country/state of its incorporation	A Colorado limited liability company 786667608		
4.	Title of the invention	Vehicle Suspension System		
5.	Name of your agent (if you have one)	Lewis & Taylor		
	"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)	5 The Quadrant Coventry CV1 2EL		
	Patents ADP number (if you know it)	711001		
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or each of these earlier applications and (if you know it) the or each application number	Country	Priority application number (if you know it)	Date of filing (day / month / year)
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and filing date of the earlier application	Number of earlier application	Date of filing (day / month / year)	
8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'yes' if: a) any applicant named in part 3 is not an inventor, or b) there is an inventor who is not named as an applicant, or c) any named applicant is a corporate body. See note (d))	yes		

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	-
Description	6
Claim(s)	- 1
Abstract	-
Drawing(s)	3 + 3

10. If you are also filing any of the following, state how many against each item.

Priority documents	-
Translation of priority documents	-
Statement of inventorship and right to grant of a patent (<i>Patents Form 7/77</i>)	-
Request for preliminary examination and search (<i>Patents Form 9/77</i>)	-
Request for substantive examination (<i>Patents Form 10/77</i>)	-
Any other documents (<i>please specify</i>)	-

11. I/We request the grant of a patent on the basis of this application.

Signature	<i>Lewis & Taylor</i>	Date
		30 March 2000

12. Name and daytime telephone number of person to contact in the United Kingdom
- | |
|---------------|
| David R Cowan |
| 01203 222756 |

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After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Vehicle Suspension System

This invention relates to vehicle suspension systems and, in particular, but not exclusively, to vehicle suspension systems in which a suspension for a vehicle wheel is associated with a drive unit.

- 5 Usually vehicles have a prime mover which drives two or more wheels of a vehicle but there have been proposals for having individual drive units for the wheels, for example, wheels which are hydraulically or electrically driven.

The object of the invention is to provide an improved vehicle suspension system incorporating a drive unit.

- 10 According to the invention a vehicle suspension system comprises a vehicle having wheels and a chassis, a suspension unit for at least one wheel, a drive unit for said wheel, and transmission means between said drive unit and said wheel, the suspension unit including a pivoted arm on the outer end of which is mounted said wheel, the pivot for said arm being mounted on said chassis, the drive unit being mounted to said chassis, and the transmission
- 15 means being arranged to accommodate pivoting of said arm relative to the chassis during operation of the vehicle.

Preferably the drive unit is a motor arranged to drive the associated wheel, and the transmission means includes a drive shaft, step down gearing, and a right angle gear box at the input of the drive to the wheel.

- 20 Conveniently there is provided a drive unit for each of a pair of wheels for the vehicle, and control means for controlling the driven wheels to obtain the desired drive characteristics of the vehicle, whereby the wheels may be driven at the same or different speeds according to predetermined driving parameters of the vehicle, for example, travelling in a straight line or travelling around bends.

In one arrangement the suspension unit is mounted on a cross beam arranged to be mounted transversely on the vehicle chassis, and with a suspension unit mounted towards each end of the beam, a drive motor for each drive wheel being mounted on the chassis in association with the suspension unit to drive the associated wheel. For a rear wheel drive vehicle the
5 cross beam may be mounted towards the rear of the vehicle and under the chassis.

The drive motor or motors of the vehicle are preferably electric motors, and the step down gearing is mounted adjacent the associated driven wheel. The motors may be mounted above the cross beam and at or above the lower level of the chassis, whereby the transmission from the motor has a downwardly extending drive shaft. Constant velocity joints may be provided
10 towards each end of the drive shaft to accommodate suspension movements of the wheel.

Further features of the invention will appear from the following description of an embodiment of the invention given by way of example only and with reference to the drawings, in which:

- Fig 1 is a plan view of part of a vehicle suspension system,
15 Fig 2 is a side elevation,
Fig 3 is a further plan view,
Fig 4 is a perspective view of a complete system omitting the drive units, and
Fig 5 is a plan view of the system of Fig 4.

Referring to the drawings these illustrate a suspension system and associated drive units
20 intended for location on a vehicle, in particular a bus, to be located towards the rear end of the bus and to provide suspension and drive for a pair of wheels located at opposite sides of the vehicle.

The vehicle (not shown) may be of generally conventional construction having a structural unit or chassis on which is mounted the body of the vehicle and within the body is located
25 the passenger space, including seating. It is intended that the interior of the body of the vehicle should have a generally flat floor although the floor may have upward protrusions

where the seating is located for the purpose to be described.

In the present vehicle two rear wheels at opposite sides of the vehicle are intended to be the drive wheels but are each driven by independent drive units. The invention has particular application to so-called hybrid vehicles which have two power sources, one an electric power source powered by electric storage means, and the other a primary power source such as an internal combustion engine which is used to generate electric power upon depletion of the electric storage means. The invention is primarily concerned with buses having electric drive units powered from the electric storage means.

Mounted to the underside of the rear of the chassis of the vehicle is a beam 10 which is arranged to extend transversely to the direction of travel of the vehicle. It is fixed to the chassis through vibration isolators 11 whereby to reduce the transmission of vibrations in the beam 10 to the chassis. The vibration isolators 11 are mounted on a pair of arms 12, spaced from one another along the beam inwardly of the ends of the beam 10.

Mounted towards each end of the beam and rigidly attached thereto is a support member 13 carrying a pivot 14 extending parallel to and spaced upwardly from the beam 10 and on which is mounted a trailing arm suspension unit 15. The suspension unit 15 is a trailing arm unit in the form of a triangular frame pivotable about the axis of the pivot 14 at one corner, having a mounting 16 at another corner for location of a hub 24 for a ground engaging wheel (not shown) and having at the other corner an outwardly-extending mounting pad 17 for a resilient air suspension unit (not shown) which is located between a part of the vehicle chassis and the pad 17.

Each trailing arm suspension unit 15 is associated with a drive unit including an electric drive motor 18 which is rigidly mounted on the vehicle chassis. In practice the motor 18 is located in a housing (not shown) formed as a protrusion in the floor of the vehicle body which lies above the level of the chassis. Drive from the motor 18 is through a constant velocity joint 19, a drive shaft 20, to a further constant velocity joint 21, and then to a spiral bevel gearbox 22 by which a reduction in the rotational speed of the drive is achieved. Drive from

the spiral bevel gearbox 22 is transmitted to a right angle gearbox 23 so that the drive axis is aligned with the rotational axis of the hub 24 and associated wheel. Between the right-angle gearbox and the wheel hub 24 on which the wheel is mounted there is located planetary reduction gearing 25 to further reduce the drive ratio to the associated hub 24 and wheel. In practice the motor 18 is rotating at a high speed during driving of the wheel, for example 8000 rpm, and a significant reduction is obtained through the gearing to impart a suitable speed of rotation of the wheel.

The constant velocity joints 19 and 21 are of the kind permitting the distance between the motor 18 and the hub 24 and gearbox assembly to change to accommodate movement of the suspension unit 15. The planetary gears 25 have a gear reduction, for example of the order of 10:1, and may be in the form of two planetary gears in series. The spiral bevel gear 22 may have a reduction ratio of the order of 1.6:1.

In providing the drive assembly it will be appreciated that the axis of pivoting 14 of the trailing arm suspension unit 15 lies to one side and below the drive shaft 20 and the drive assembly is arranged to accommodate this.

Movement of the trailing arm suspension unit 15 is under the influence of the resilient mounting provided by the pad 17 and the associated airbag abutting against a portion of the vehicle chassis to provide a damping movement in the upwards direction. To support the unit 15 in the downward direction it is supported from the vehicle frame and various arrangements can be used. An arm 31 may be provided having a rubber support 30 between the arm and the frame. Alternatively a steel cable (not shown) may extend between the arm 31 and the frame. A shock absorber 32 may also be provided between the arm 15 and the frame attached by a bracket 33.

Each of the motors 18 is supplied with electrical power from a common source in the form of electric storage means (not shown). In order to ensure that the motors 18 rotate at the appropriate speeds relative to one another there is provided a control system whereby power to the motors is controlled. In its simplest form the control system controls the motors to

rotate at the same speed so that the drive wheels each rotate at the same speed which would normally take place when the vehicle is travelling in a straight line. When the vehicle is travelling around bends the wheels need to rotate at different speeds to accommodate for the lack of a differential between the wheels, so that the wheel at the outer side of the vehicle travelling around the bend rotates at a faster speed than the wheel at the inner side. Thus the rotational speeds of the motors 18 are determined by the control means according to the turning circle of the vehicle and other desired driving characteristics. Moreover it is advantageous for the wheel at the outer side of the bend to be driven at greater torque than the wheel at the inside to serve to assist turning of the vehicle. The control means is arranged to monitor the parameters of the vehicle travel to select the power to each motor 18, including reverse drive.

In addition the electric drive to the wheels may be utilised to provide regenerative braking by which electrical power is generated during braking of the vehicle to be fed back into the electric storage means and conserve energy, obtaining more efficient utilisation of the power available.

The wheel hub 24 is fitted with a disk 27 of a disk brake assembly for each wheel whereby the wheels are braked in the usual manner.

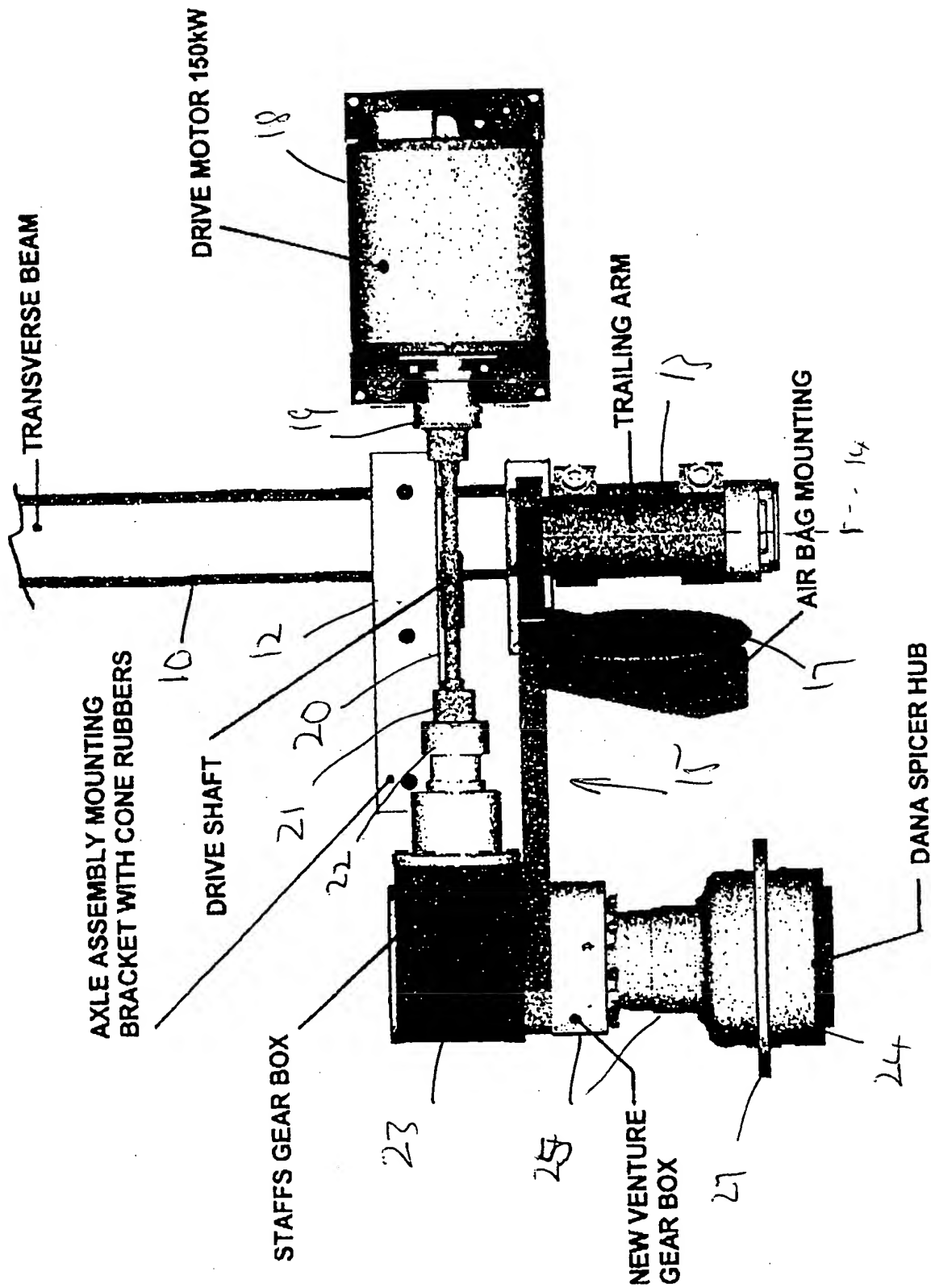
The provision of the suspension and drive system in a manner described permits the assembly to be assembled prior to fitting to the vehicle to ensure that the components are assembled in the desired orientation without misalignments and other problems which may arise if the components were mounted directly to the vehicle chassis. The preassembled construction is attached to the vehicle chassis at predetermined specific locations on the chassis to ensure that the components are in the right relationship to one another and to the vehicle.

It will be seen that the vehicle hubs 24 and wheels, each being mounted on the trailing arm suspension unit 15 are independently suspended on the vehicle and can move up and down independently about their associated axes 14 to accommodate the road contours in the usual

way, and under the restraint and damping action of the airbags. At the same time drive is be transmitted to the wheels from the motors 18 through the drive transmission arrangement which permits the transmission of power to the hubs irrespective of the position of the wheel due to the suspension movements.

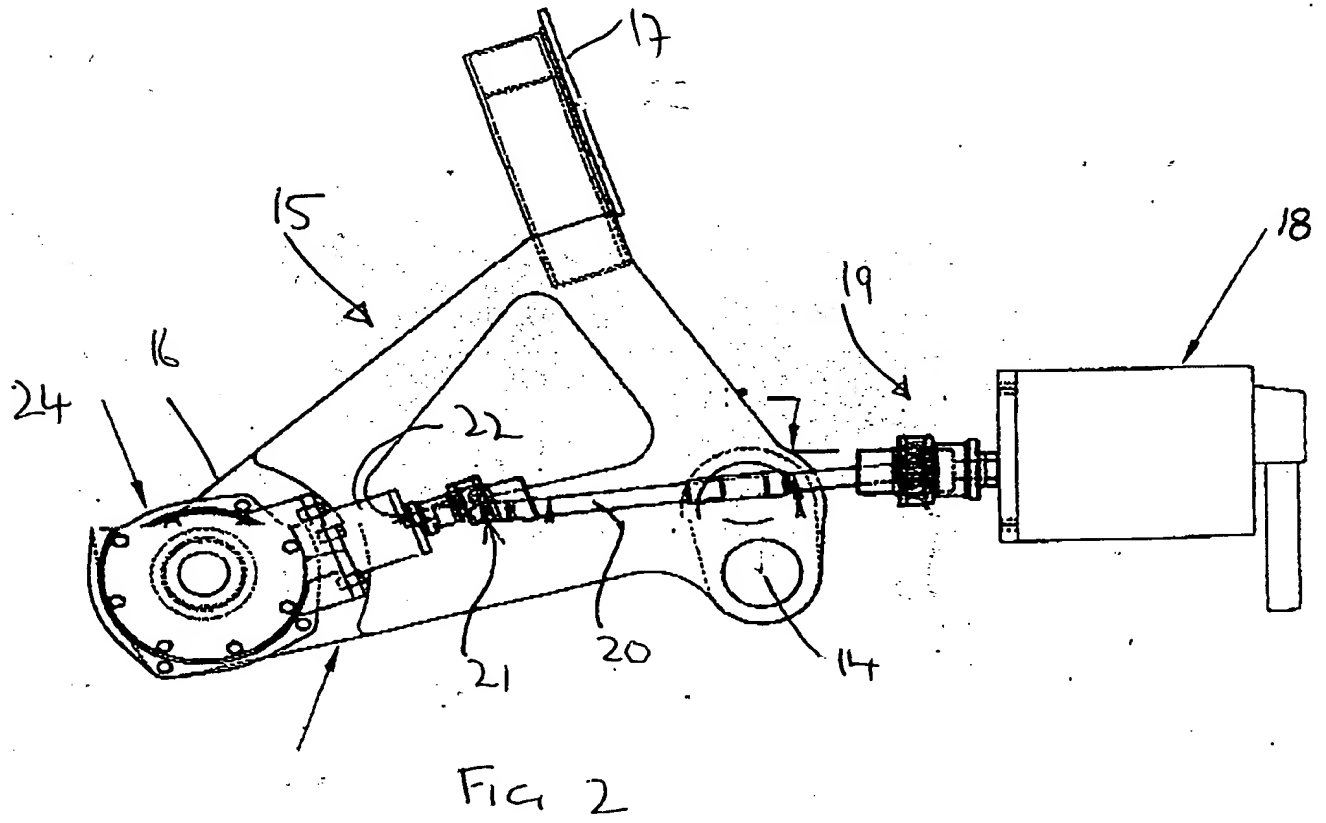
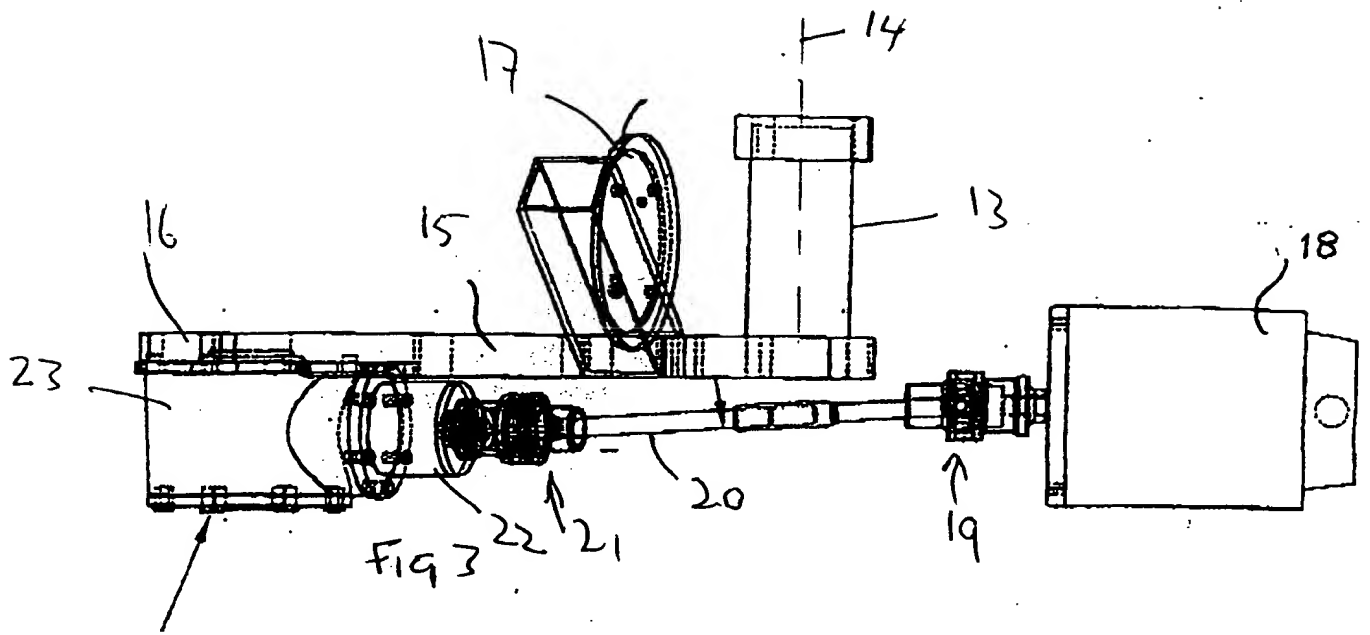
- 5 The motors 18 being located in housings formed on the vehicle chassis are protected and, due to the relatively small size of the motors, their location on the vehicle body does not effect the ability to produce a flat floor within the vehicle. The motors 18 may be liquid cooled and their location further assists in utilising this kind of motor.

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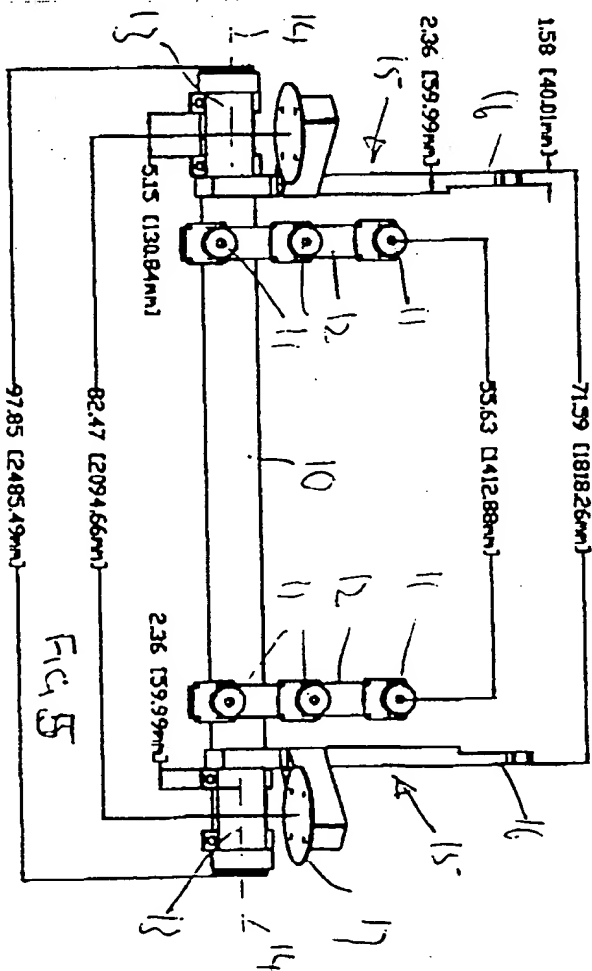
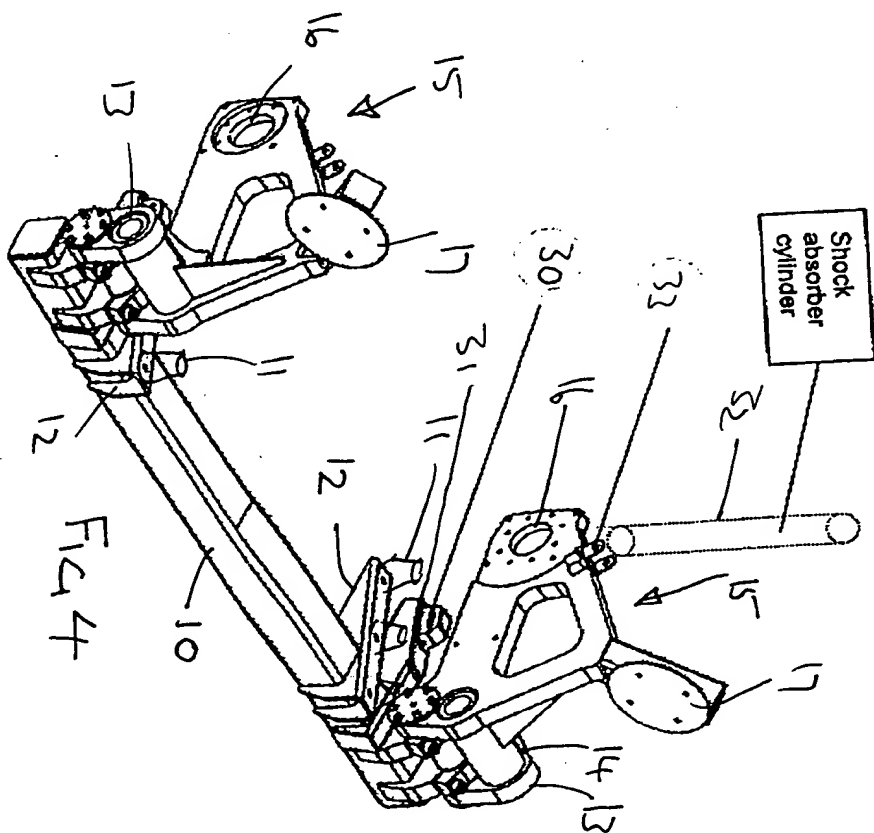
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